Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended) An adaptive antenna radio communication device comprising:

an array antenna made up of a plurality of antenna elements receiving high frequency signals that are transmitted by a multi-carrier;

a demultiplexer for demultiplexing one of the high frequency signals received by ~~said~~ a respective one of the antenna elements to a plurality of sub-carrier signals;

Nd divided band direction estimating units for estimating the direction-of-arrival of a radio wave by dividing the ~~entire~~ communication band being said multi-carrier transmitted into Nd bands and using ones of the plurality of sub-carrier signals belonging to the respective divided bands, ~~(however~~ wherein~~,~~ Nd is at least 2 ~~or more~~ or a positive integer less than ~~the~~ a number of sub-carriers used for multi-carrier transmission~~,) and using sub-carrier signals belonging to the respective divided bands~~;

a divided band array weight creating unit for creating a weight of a receive array having a directional beam in the direction of estimation by said divided band direction estimating unit for said respective divided bands;

a sub-carrier directivity creating unit for creating a directivity by multiplication-combining the receive array weight created in each divided band with the corresponding sub-carrier signal belonging to the divided band; and

a demodulating unit for demodulating data by using the output of said sub-carrier directivity creating unit.

2. (Withdrawn) The adaptive antenna radio communication device according to claim 1,

wherein said divided band direction estimating unit calculates pilot signal correlation values with the respective input sub-carrier signals using a known pilot signal embedded in a sub-carrier signal, and estimates the direction-of-arrival based on the correlation values of the pilot signal correlation values calculated between the same sub-carrier signals received by different antenna elements.

3. (Withdrawn) The adaptive antenna radio communication device according to claim 2,

wherein said divided band direction estimating unit estimates the direction-of-arrival using correlation matrices integrating correlation matrices of the respective sub-carriers belonging to the sub-carrier signals.

4. (Withdrawn) The adaptive antenna radio communication device according to claim 2,

wherein said divided band direction estimating unit estimates the direction-of-arrival using a correlation matrix R expressed as

$$R = V_1 V_1^H + V_2 V_2^H + \cdots + V_L V_L^H$$

where L is the number of sub-carriers belonging to the sub-carrier signals; Vk is a column vector having a pilot signal correlation value as an m-th element in the m-th antenna element with respect to the k-th sub-carrier signal; and H is a complex conjugate transposed operator.

5. (Withdrawn) The adaptive antenna radio communication device according to claim 2,

wherein said divided band direction estimating unit estimates the direction-of-arrival by using a correlation vector integrating correlation vectors of the respective sub-carriers belonging to the sub-carrier signals.

6. (Withdrawn) The adaptive antenna radio communication device according to claim 2,

wherein said divided band direction estimating unit estimates the direction-of-arrival using a correlation vector z expressed as

$$z = V_{1X} * V_1 + V_{2X} * V_2 + \cdots + V_{LX} * V_L$$

where L is the number of sub-carriers belonging to the sub-carrier signals; Vk is a column vector having a pilot signal correlation value as an m-th element in the m-th antenna element with respect to the k-th sub-carrier signal; Vkx is an x-th element of said column vector Vk (however, x is a positive integer less than the number of antenna elements); and * is a complex conjugate operator.

7. (Original) The adaptive antenna radio communication device according to claim 1,

wherein said divided band direction estimating unit further has a path search unit for calculating a delay profile by calculating a cross correlation between respective input sub-carrier signals using a known pilot signal embedded in the sub-carrier signal and detecting a plurality of path arrival timings from the delay profile, and estimates the direction-of-arrival based on the correlation value of the pilot signal correlation value calculated between the same sub-carrier signals received by different antenna elements in the respective path arrival timing.

8. (Original) The adaptive antenna radio communication device according to claim 7,

wherein said divided band direction estimating unit estimates the direction-of-arrival using a correlation matrix integrating correlation matrices of the respective sub-carriers detected in the respective sub-carriers belonging to the sub-carrier signals.

9. (Original) The adaptive antenna radio communication device according to claim 7,

wherein said divided band direction estimating unit estimates the direction-of-arrival using a correlation matrix R expressed as

$$R = \sum_{k=1}^{L} \sum_{p=1}^{S} V_k(p) V_k(p)^H$$

where L is the number of sub-carriers belonging to the sub-carrier signals; Vk(p) is a column vector having the pilot signal correlation values as an m-th element in the m-th antenna element of the p-th arrival path (the number of whole arrival paths is specified as S) with respect to the k-th sub-carrier signal; and H is a complex conjugate transposed operator.

10. (Original) The adaptive antenna radio communication device according to claim 7,

wherein said divided band direction estimating unit estimates the direction-of-arrival using a correlation vector integrating correlation vectors of the respective sub-carriers detected in the respective sub-carriers belonging to the sub-carrier signals.

11. (Original) The adaptive antenna radio communication device according to claim 7,

wherein said divided band direction estimating unit estimates the direction-of-arrival using a correlation vector z expressed as

$$z = \sum_{k=1}^{L} \sum_{p=1}^{S} V_{kx}(p) * V_k(p)$$

where L is the number of sub-carriers belonging to the sub-carrier signals; Vk(p) is a column vector having the pilot signal correlation values as an m-th element in the m-th antenna element of the p-th arrival path (the number of whole arrival paths is specified as S) with respect to the k-th sub-carrier signal and * is a complex conjugate operator.

12. (Withdrawn) The adaptive antenna radio communication device according to claim 3,

wherein said divided band direction estimating unit estimates the direction-of-arrival by any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method using said correlation matrix R.

13. (Original) The adaptive antenna radio communication device according to claim 8,

wherein said divided band direction estimating unit estimates the direction-of-arrival by any one of the MUSIC method, ESPRIT method, CAPON method or Fourier method using said correlation matrix R.

14. (Withdrawn) The adaptive antenna radio communication device according to claim 3,

wherein said divided band direction estimating unit has a spatial smoothing processing unit for performing spatial smoothing processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the spatial smoothing processing unit.

15. (Withdrawn) The adaptive antenna radio communication device according to claim 5,

wherein said divided band direction estimating unit has a spatial smoothing processing unit for performing spatial smoothing processing on said correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from said spatial smoothing processing unit.

16. (Original) The adaptive antenna radio communication device according to claim 7, wherein said divided band direction estimating unit has a spatial smoothing processing unit for performing spatial smoothing processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the spatial smoothing processing unit.

17. (Original) The adaptive antenna radio communication device according to claim 8, wherein the divided band direction estimating unit has a spatial smoothing processing unit for performing spatial smoothing processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the spatial smoothing processing unit.

18. (Withdrawn) The adaptive antenna radio communication device according to claim 3,

wherein said divided band direction estimating unit has a unitary converting unit for performing unitary conversion processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the unitary converting unit.

19. (Withdrawn) The adaptive antenna radio communication device according to claim 5,

wherein said divided band direction estimating unit has a unitary converting unit for performing unitary conversion processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the unitary converting unit.

20. (Original) The adaptive antenna radio communication device according to claim 7,

wherein said divided band direction estimating unit has a unitary converting unit for performing unitary conversion processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the unitary converting unit.

21. (Original) The adaptive antenna radio communication device according to claim 8,

wherein said divided band direction estimating unit has a unitary converting unit for performing unitary conversion processing on the correlation matrix R and estimates the direction-of-arrival by using any one of the MUSIC method, ESPRIT method, CAPON method and Fourier method to the output from the unitary converting unit.

22.-25. (Cancelled).

26. (Withdrawn) The adaptive antenna radio communication device according to claim 1, further comprising:

in a radio system being multi-carrier transmitted in a time division duplex (TDD) method,

a sub-carrier transmission weight creating unit using a weight of a receive array created in the divided band array weight creating unit as a weight of a transmission array; and

a sub-carrier transmission directivity creating unit for transmitting a directional beam using a weight of a transmission array common to the respective divided bands.

27. (Withdrawn) The adaptive antenna radio communication device according to claim 1, further comprising:

in a radio system being multi-carrier transmitted in a time division duplex (TDD) method or a frequency division duplex (FDD) method,

a sub-carrier transmission weight creating unit for calculating a weight of a transmission array in order to create a transmitting directional beam in the direction of estimation giving maximum received power among all directions of estimation by said divided band direction estimating units; and

a sub-carrier transmission directivity creating unit for transmitting a directional beam common to the entire divided band using the weight of the transmission array.

28. (Withdrawn) The adaptive antenna radio communication device according to claim 1, further comprising:

in a radio system being multi-carrier transmitted in a time division duplex (TDD) method or a frequency division duplex (FDD) method,

a sub-carrier transmission weight creating unit for calculating a deviation of the estimation direction outputted from said divided band direction estimating unit, calculating a weight of a transmission array for creating a transmitting directional beam in the average direction of direction estimation values outputted from all of said divided band direction estimating units when the deviation is less than the predetermined value, or calculating the weight of the transmission array in the direction of estimation giving a predetermined number of the upper received power among all of the divided bands when the deviation is greater than the predetermined value.

29. (Withdrawn) The adaptive antenna radio communication device according to claim 1,

wherein the multi-carrier transmission uses sub-carrier signals to which orthogonal frequency division multiplexing (OFDM) is applied.

30.-31 (Cancelled).

32. (Withdrawn) The adaptive antenna radio communication device according to claim 1,

wherein the multi-carrier transmission uses sub-carrier signals in which users multiplex by code division in the direction of frequency axis or time axis.

33.-34. (Cancelled).

35. (Withdrawn) The adaptive antenna radio communication device according to claim 32,

wherein a weight of a transmission array or a weight of a receive array is created for the respective multiplexed users for directional receiving.

36.-37. (Cancelled).

38. (Withdrawn) The adaptive antenna radio communication device according to claim 35,

wherein said divided band array weight creating unit has a directional beam in the direction estimation result of the divided band direction estimating unit in its divided band and creates a weight of a receive array for creating a null in the estimation direction of other multiplexed users.

39.-40. (Cancelled).

41. (Withdrawn) The adaptive antenna radio communication device according to claim 35,

wherein said sub-carrier transmission weight creating unit has a directional beam in the direction of a desired user and creates a weight of a transmission array for creating a null in the direction of other multiplexed users.

42.-43. (Cancelled).